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No. 650

WIND-TUNNEL TESTS OF A CLARK Y WING

HAVING SPLIT FLAPS WITH GAPS

By Carl J. Wenzinger  
Langley Memorial Aeronautical Laboratory

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#### SUMMARY

Tests were made in the N.A.C.A. 7- by 10-foot wind tunnel of a Clark Y wing having split flaps with a gap between the flap and the lower surface of the wing. Lift, drag, and pitching moments were measured for the wing with three different sizes of flap. It was found that any gap between the flap and the wing reduced the lift, the drag, and the pitching moments, but that the center-of-pressure movement and the ratio of lift to drag were little affected.

#### INTRODUCTION

The unbalanced type of split flap used on airplanes ordinarily possesses the undesirable characteristic of relatively large control forces for its operation (reference 1). One method of improving this condition is to arrange the flap to extend or to retract through the lower surface of the wing. It appears desirable to make the actual flap chord as small as possible and to extend the flap out into the air stream to as great a distance as practicable. A small-chord flap would therefore have a gap between the flap and wing when the flap is extended.

The present tests were made to determine the effects of gaps of different size on the wing characteristics when the trailing edge of the flap is held at a fixed distance from the lower surface of the wing.

#### MODELS AND TESTS

The models tested are shown in figure 1 as A, B,

and C. Clark Y wooden wings of rectangular plan form with 10-inch chord and 60-inch span were used. The flaps were made of 1/16-inch-thick steel and were fastened to the lower surface of the wing by flat metal strips with the flat sides parallel to the air stream. The flaps were held fixed at an angle of  $60^\circ$  to the wing; this angle has been found from previous tests to be the optimum for  $C_{L_{max}}$  when 0.20c split flaps are used.

The tests were made with the model mounted on the standard force-test tripod in the N.A.C.A. 7- by 10-foot open-jet wind tunnel (reference 2). The dynamic pressure was maintained constant at 16.37 pounds per square foot, corresponding to an air speed of about 80 miles per hour at standard sea-level conditions. The average test Reynolds Number based on the wing chord was 609,000. The angles of attack ranged from below zero lift to above the stall of the wing for each arrangement.

## RESULTS AND DISCUSSION

The results are given in the form of absolute coefficients of lift, drag, and pitching moment:

$$C_L = \frac{\text{lift}}{qS}$$

$$C_D = \frac{\text{drag}}{qS}$$

$$C_{m_{c/4}} = \frac{\text{pitching moment about quarter-chord point}}{qcS}$$

where  $q$  is dynamic pressure

$S$ , the wing area

$c$ , the wing chord

The data have all been corrected for the effects of the wind-tunnel jet boundaries to aspect ratio 6 in free air.

Plots of  $C_L$ ,  $C_D$ , and center of pressure against angle of attack are given in figure 2 for the various arrangements tested. It will be noted that the flap without gap gives higher lift and drag up to the stall than any of the flaps tested with gaps. The center-of-pressure movement is little affected over the usable flight range. Any gap between flap and wing, for the same overall chord of flap including the gap, has a detrimental effect.

Ratios of lift to drag and the pitching-moment coefficients are plotted in figure 3 against lift coefficient for the wing with flap. Over most of the range of lift coefficients, the ratios of lift to drag are little different for the various gaps between flap and wing, so that either flap would function as an air brake. The pitching-moment coefficients, however, are considerably reduced with increased gap between flap and wing.

Figure 4 shows the effect on the maximum lift coefficient and on the drag at maximum lift of reducing the chord of a 0.20c split flap. (See also references 3 and 4.) In one case the leading edge of the flap is held fixed and the trailing edge removed (no gap), and in the other case the trailing edge is held fixed and the leading edge of the flap is removed (with gap). It will be immediately noted that any gap between flap and wing, for the same reduction of chord, has an adverse effect on the maximum lift and also slightly reduces the drag at maximum lift. These effects occur even though the same size of flap with gap extends farther out into the air stream below the wing than does the solid flap.

#### CONCLUDING REMARKS

It is concluded from the results of the tests that any gap between the flap and the wing reduces the lift, the drag, and the pitching moments but that the center-of-pressure movement and the ratio of lift to drag are little affected.

Langley Memorial Aeronautical Laboratory,  
National Advisory Committee for Aeronautics,  
Langley Field, Va., May 4, 1938.

## REFERENCES

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2. Harris, Thomas A.: The 7 by 10 Foot Wind Tunnel of the National Advisory Committee for Aeronautics. T.R. No. 412, N.A.C.A., 1931.
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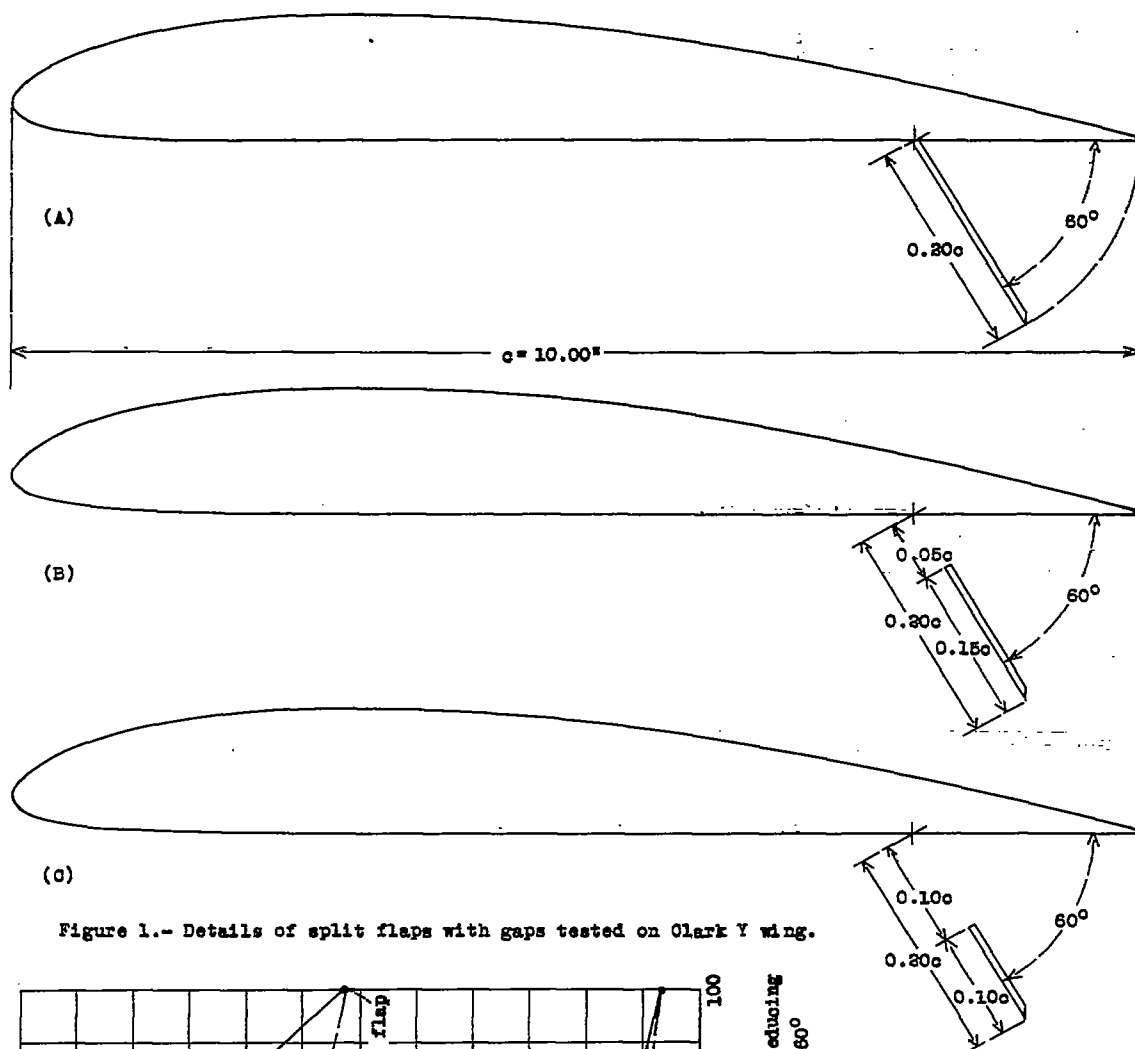


Figure 1.- Details of split flaps with gaps tested on Clark Y wing.

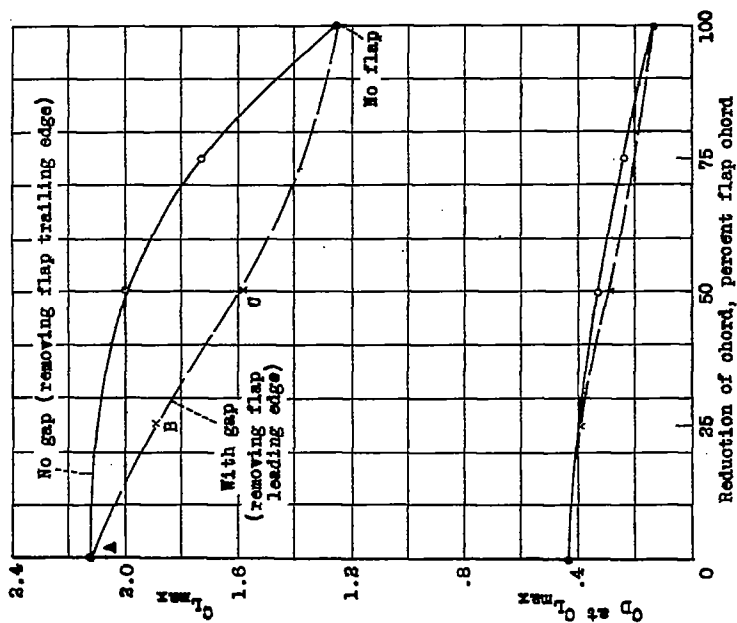


Figure 4.- Effect on  $C_{p_{max}}$  and on  $C_{p_{max}}$  at  $C_{p_{max}}$  of reducing the chord of a 0.80c split flap.  $\delta_f = 80^\circ$

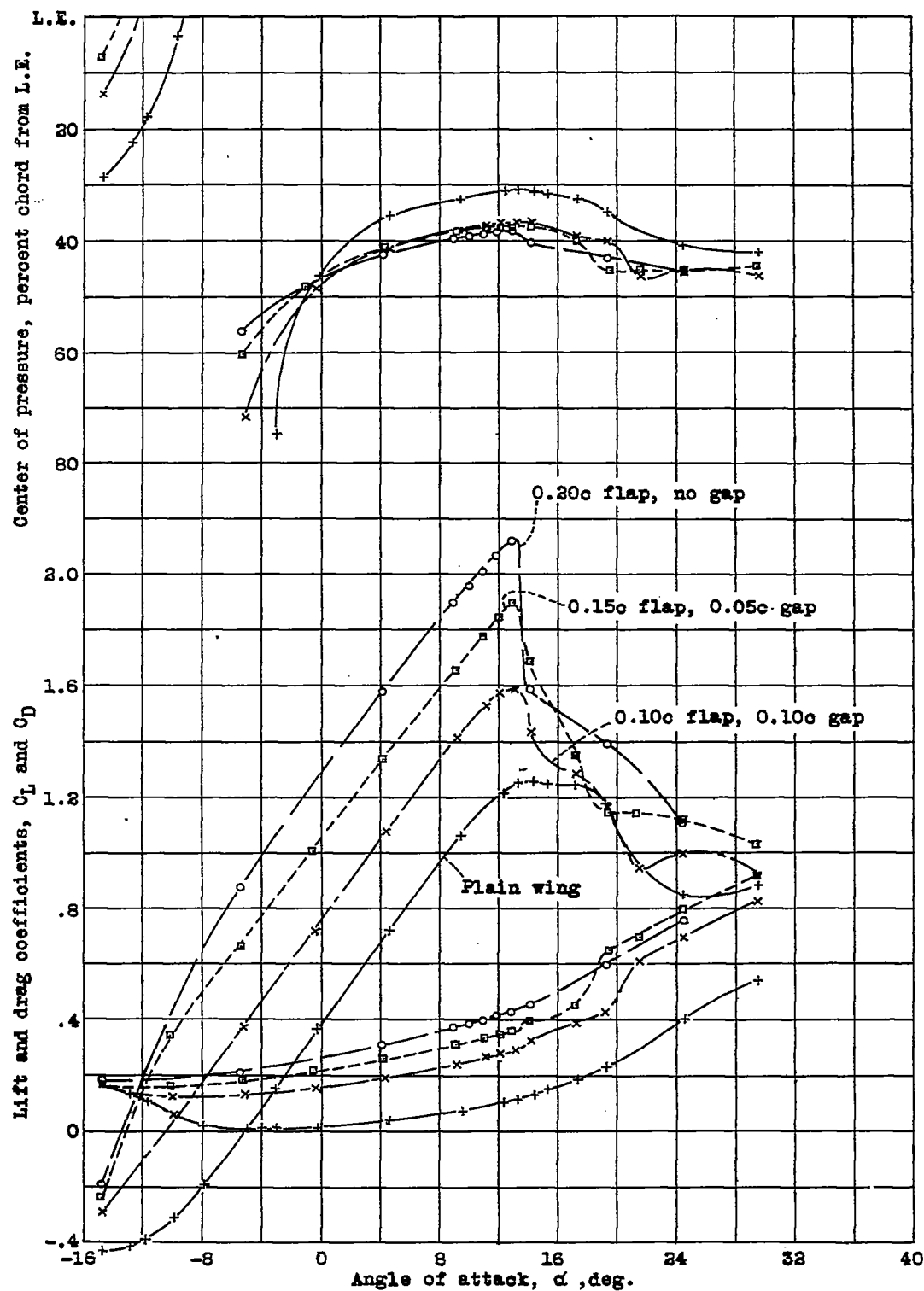


Figure 3.- Lift, drag, and center-of-pressure characteristics of Clark Y wing with full-span split flaps and gap between flap and wing.

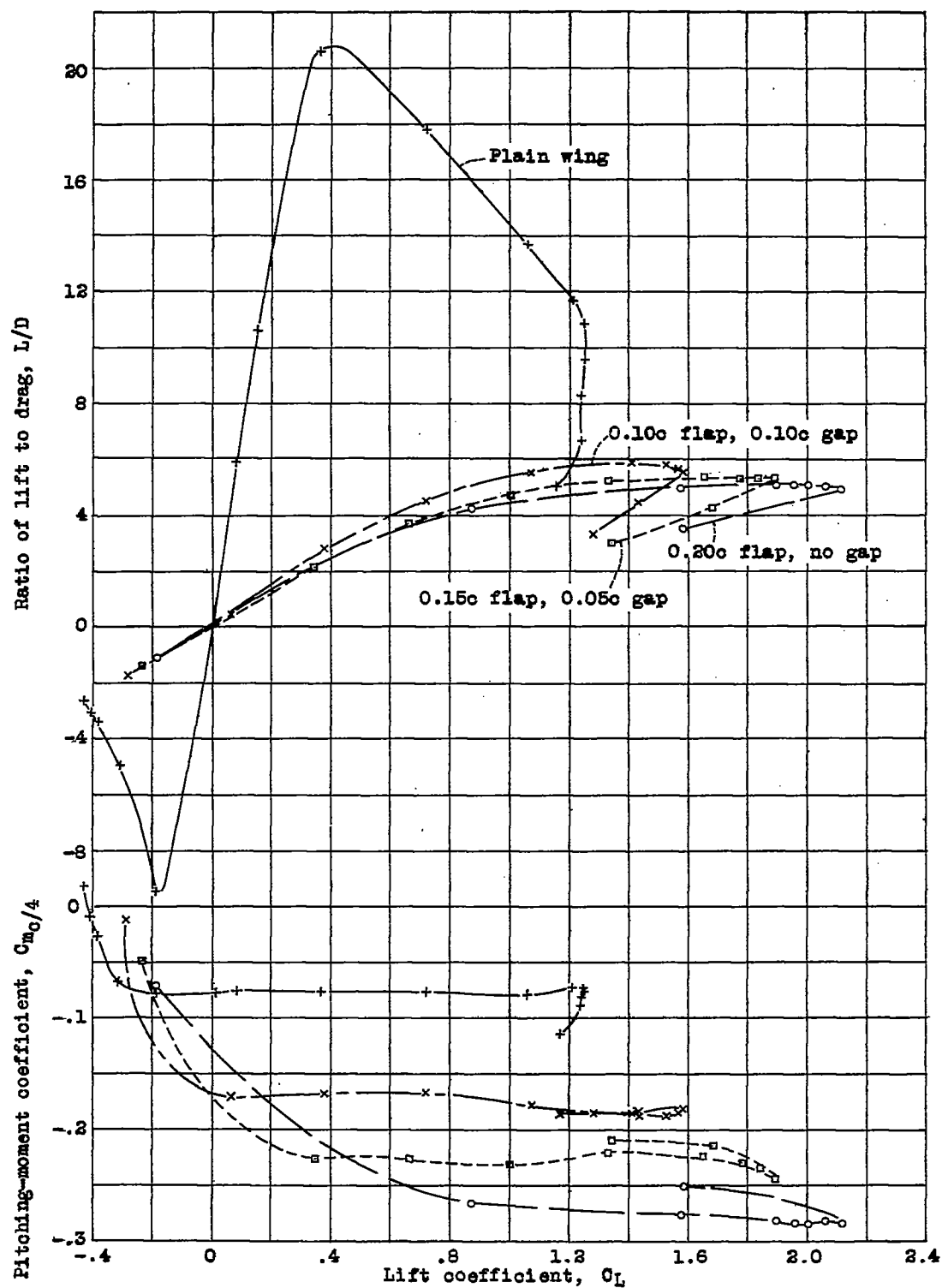


Figure 3.- Pitching-moment coefficients and ratios of lift to drag for Clark Y wing with full-span split flaps and gap between flap and wing.